condensation and de-condensation, mitotic spindle morphogenesis, and nuclear envelope assembly.

Ok, but I've heard you can't image* Xenopus *embryos? Actually, *Xenopus* is great for imaging in cell biology because the cells of the embryo are unusually big at diameters of over 30 μm.

If* Xenopus *is so widely used, why haven't I heard of it? Well, *Xenopus* has diverse applications, and so people using them have tended to associate based on scientific interests rather than the organism. This has meant that *Xenopus* has lagged somewhat in terms of resource development, but that's changing now. Genome sequencing is underway for both *X. laevis* and *X. tropicalis*, an effort has been launched to build a Xenopus ORFeome for large-scale functional studies and Xenbase, the *Xenopus* model organism database, is expanding rapidly. You might not have heard about it, but there's a good chance that someone's using *Xenopus* just down the hall.

Where can I read more?

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Eye position predicts what number you have in mind

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Despite the apparent simplicity of picking numbers at random, it is virtually impossible to produce a sequence of truly random numbers. Although numbers seem to pop-up spontaneously in one's mind, their choice is invariably influenced by previously generated numbers [1]. Here, we demonstrate how the eyes and their position give an insight into the nature of the systematic choices made by the brain's 'random number generator'. By measuring a person's vertical and horizontal eye position, we were able to predict with reliable confidence the size of the next number — before it was spoken. Specifically, a leftward and downward change in eye position announced that the next number would be smaller than the last. Correspondingly, if the eyes changed position to the right and upward, it forecast that the next number would be larger. Apart from supporting the old wisdom that it is often the eyes that betray the mind, the findings highlight the intricate links between supposedly abstract thought processes, the body's actions and the world around us.

Sitting in a dark room, twelve right-handed men acted as random number generators. Paced by an electronic metronome (1 Hz) they named 40 numbers between 1 and 30 in a sequence 'as random as possible'. Each participant's eye position was measured with dual search coils (Skalar, Delft, The Netherlands, see [2]) as they sat within a 1.4 m diameter coil frame, which generated three orthogonal magnetic field. The voltages induced on the coils were proportional to the orientation of the coil relative to the magnetic field and the signals were sampled at 1000 Hz and a 16 bit resolution. The subjects' spoken responses were recorded and synchronized with eye position. Saccades and blink artifacts were detected and removed with an interactive computer program on the basis of velocity and noise criteria. For each number, we computed the average horizontal and vertical eye position during the 500 msec interval before it was named.

On the basis of consistent research showing that small numbers are associated with the left and upper parts of space and large numbers with the right and lower [3,4], we predicted that selecting a number smaller than the last would be anticipated by leftward (downward) changes in eye position. Similarly, shifts to a larger number would be accompanied by rightward (upward) changes in eye position. Our results show that both horizontal and vertical changes in eye position predicted the direction of the change in number magnitude well above the chance level of 50% (Figure 1A; horizontal mean: 61.6%, SE 2.6: $t(11) = 4.47$, $p < 0.001$; vertical mean 65.7% SE 1.6: $t(11) = 9.73$, $p < 0.0001$).

To assess whether the size of the change in eye position predicted the size of the change in number, we performed a repeated-measures regression analysis for each individual participant [5]. Numerical distance (number 'n + 1' minus number 'n') was the dependent variable, and the corresponding changes of the horizontal and vertical eye position were used as predictors. Crucially, the individual regression weights for changes in horizontal (mean = 0.126, SE = 0.03, $t(11) = 3.95$, $p < 0.002$) and vertical eye position (mean = 0.127, SE = 0.03, $t(11) = 4.68$, $p < 0.001$) were significantly different from 0 (one-sample t-test). A large change in eye position therefore predicted a marked change in number size, whereas a small change indicated that the next random number would be of comparable magnitude (Figure 1B,C).

To a substantial degree, changes in eye position allow us to predict a number that is in a person's mind before it is named. Not only does the *direction* of the change in eye position indicate whether a smaller or larger number is picked, but also the *degree* of change reliably reflects the size of the numerical shift. Our data are correlative, and the intriguing question remains: Does merely thinking of a number cause a change in eye position? Alternatively, does the

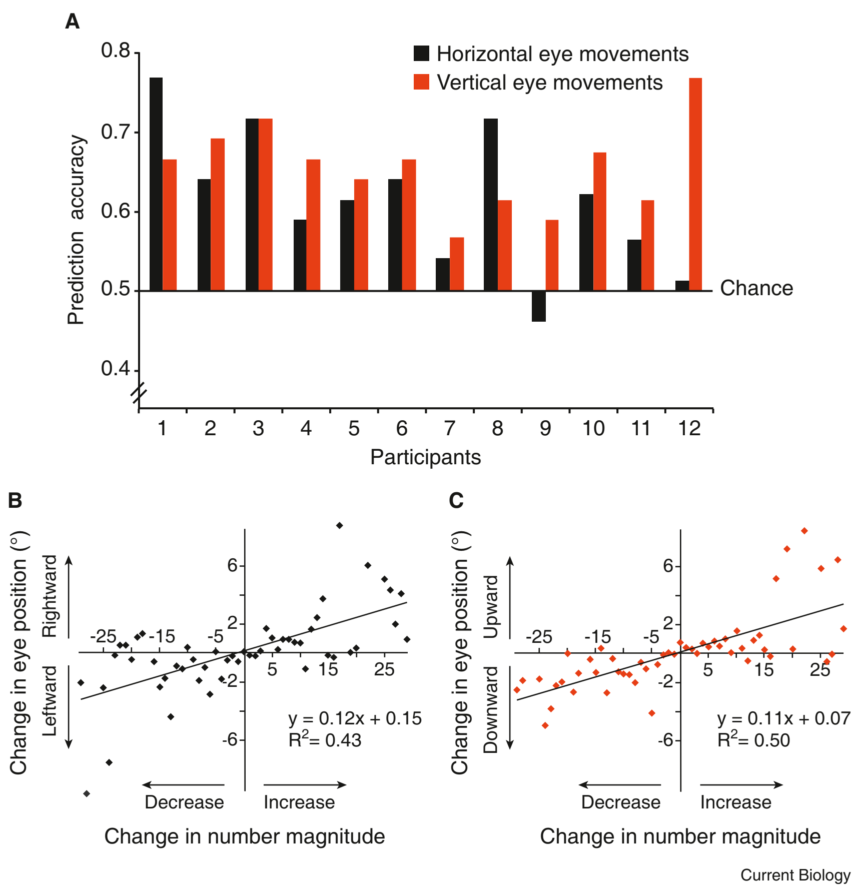

Figure 1. Eye position predicts number choice.

(A) The bar graph illustrates how accurately horizontal and vertical eye position predicts whether an individual participant is going to name a number which is smaller or larger than the preceding number. (B,C) Changes of eye position (group data) as a function of change in number magnitude (random number generated on trial ‘n+1’ minus number generated on trial ‘n’). (B) Median horizontal; (C) median vertical changes.

direction of an ocular shift constrain the selection of numbers? In any case, our findings substantiate earlier claims for an analogical representation of numbers [3]. The results also suggest, however, that the notion of a left-to-right oriented mental number line might be an oversimplification. In many individuals (Figure 1A) the mental representation of numbers may be better described in a diagonal fashion (left bottom to right top, see also [4]).

An influential theory — the ‘theory of magnitude’; see [6]) considers coordinate information in ‘number space’ to be just one instance of magnitudes within a single metric system unifying size information of a broad range of units, from spatial extension to temporal duration. It is postulated that this general magnitude system is mediated by inferior parietal structures of the brain and that it encodes information used in actions [6]. This hypothesis successfully predicted interactions between numbers and goal-directed hand movements. Exposure to small or large numbers has, for example, been shown to modify grip aperture (small, large) in grasping behaviour [7,8]. Our results are therefore particularly interesting because they demonstrate links between numbers, magnitude and movement in a task where no action planning was required — especially as they relate to a task-irrelevant oculo-motor system. Our study is also noteworthy because it demonstrates that simply thinking of random numbers is accompanied by systematic changes in eye position. Lateral eye movements have previously been linked specifically to the computation of mental arithmetic problems, such as addition and subtraction [9].

Although we have not directly investigated the neural mechanisms which link random number generation to eye position, it is interesting to speculate about these mechanisms. One possibility is that abstract cognitive tasks, such as random number generation, automatically adopt spatial strategies based on the exploitation of neural mechanisms which evolved primarily for navigating and interacting with the real world. In conclusion, a close look at the eyes may not only reveal what is in a person’s mind, but also illustrate how abstract thoughts are grounded in basic sensory-motor processes [10].

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